REMARKS

Applicants acknowledge that the outstanding Office Action has been made final. Accordingly, a Request for Continued Examination has been submitted herewith, and further consideration of this application in view of the foregoing amendments is respectfully requested.

Claims 1-6, 8-18, 21, 24 and 25 have been rejected under 35 U.S.C. §103(a) as unpatentable over Bilgen et al (German patent document DE 198 39 383, which corresponds to U.S. Patent No. 6,458,226) in view of Hathaway (U.S. Patent No. 2,261,878) and Fritz et al (NPL, *"Fertigungs Technik"*, including an English translation of Figures 5-24 and 5-26). In addition, Claims 7 and 16 have been rejected under 35 U.S.C. §103(a) as unpatentable over the same three references, and further in view of Borowikow (German patent document DE 100 30 823). However, for the reasons set forth hereinafter, Applicants respectfully submit that all claims of record in this application, including Claims 26-44 inserted by the previous amendment, distinguish over the cited references, and are allowable.

The present invention is directed to a method for thermomechanical heat treatment of steel rods, in which the rods are deformed in a single step of skew rolling, coordinated with a particular pattern of heat treatment. As a result of this claimed combination of skew rolling coordinated with treatment, as defined

in detail in Claims 1, 25 and 26, a desired twisting and a maximum deformation of the material which makes up the rods is generated in the marginal (radially outer) portions of the rods, so that a desired deformation gradient, and consequently (after the heat treatment) a desired crystal structure, are achieved across the cross section of the rod, providing an exceedingly strong marginal area.

According to a feature of the invention, by an appropriate selection of the rolling parameters, as described in the specification, a critical degree of deformation is achieved by a single rolling process, so that ultimately a gradient of the degree of crystallization from the outside of the rod to the inside results. That is, when the rod is subsequently reheated, hardened and tempered, the marginal zone (near the surface of the rod) is characterized by a martensite structure of great strength. (See, for example, page 4 of the specification at lines 1-15.)

Accordingly, as described above, according to the present invention, the heat treatment and skew rolling of the rod are coordinated, utilizing a single deformation step, which results in a cross sectional distribution of the crystalline structure that corresponds to a desired strength distribution over the cross section of the rod. This feature is described in the specification at page 4, lines 1-15 and page 5, line 25 through page 6, line 14 as follows:

"On account of the process-specific peculiarities of the skew rolling and due to a targeted establishment of the rolling parameters, a predetermined twisting of the material in the marginal area of the rods and a transformation gradient over the cross section of the rod set in. Since the direction of transformation during the skew rolling is at an angle to the axis of the material and the maximum of the transformation is in the marginal region of the rods, the structural stretching in this marginal zone, caused by the transformation, is especially greatly pronounced and the structural alignment corresponds to the transformation direction and also extends at an angle to the axis of the [r]olled material. After the critical degree of transformation is exceeded, the dynamic recrystallization process takes place with special intensity in this marginal zone, so that a gradient of the degree of recrystallization from the outside to the inside may be noted over the cross section of the rod. In the reheating following the transformation process to a temperature above Ac3, the static recrystallization is completed and leads to the formation of fine-grained austenite, especially in the marginal zone. After

hardening followed by tempering, the marginal zone is characterized by a martensite structure of great strength."

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"Due to the transformation action, after a critical transformation degree is exceeded [that is, by virtue of the skew rolling], dynamic recrystallization processes take place, which, on account of the maximum transformation, are more strongly pronounced in the marginal zone than in the core region of the rods. The targeted influencing of the formation of a transformation gradient over the cross section of the rod has the result that the first indications of a differential structure distribution appear across the cross section of the rod already during the course of the dynamic recrystallization. Thus, metallographic studies on rods in the recrystallized state, which have been rolled pursuant to the invention, show that the proportion of fine austenite crystals decreases clearly from the marginal zone toward the core region.

> The differentiated structural formation across the cross section of the rolled material is further additionally intensified by a typical peculiarity of skew rolling. Since the direction of transformation runs at an angle to the direction of the rolled material in skew rolling, a striking stretching of structure occurs especially in the marginal areas of the material due to the greater degree of transformation. The structure is also stretched at an angle to the axis of the rolled material and leads to a twisting of the material in the marginal zones."

The foregoing feature of the invention is included in Claims 1, 25 and 26, as amended. Thus, Claim 1 recites a step of deforming the steel rods "in a single deforming step, coordinated with heat treatment", and further specifies that the latter step includes heating of the steel rod to a heating temperature that is above a recrystallization temperature, equalizing the temperature, and "causing the steel rod to be deformed by skew rolling it,...such that a predetermined twisting of the material occurs in a marginal area of said rod, and a desired deformation gradient, is achieved over a cross section of the rod". As a result, "after a critical degree of deformation is exceeded, dynamic recrystallization takes place with greatest intensity in the marginal area". In this manner, when

the subsequent reheating to a temperature above Ac3 and the hardening and tempering occurs, the desired crystalline structure and strength gradient occurs.

Applicants respectfully submit that the foregoing features of the invention are not taught or suggested by the cited references, or by a combination thereof.

The previous Office Action (incorporated by reference into the present Office Action at page 5) indicated that the Bilgen et al patent discloses a process for thermomechanical treatment of steel which includes inductive heating of a starting material such as spring steel, austenitizing the product, holding its temperature for a short time, forming the material into a formed product at a temperature above the recrystallization temperature, and quenching to martensite and tempering. However, as acknowledged in the previous Office Action, Bilgen et al does not refer to a skew rolling step, or to a heat treatment coordinated with skew rolling, such as recited in the claims of the present application. Moreover, for the reasons set forth in Applicants' remarks which accompanied the amendment submitted January 8, 2009, Applicants respectfully submit that the Hathaway patent also does not teach or suggest a skew rolling process, and does not achieve "a predetermined twisting of the material in a marginal area of said rod and desired transformation gradient...over a cross section of the rod" as recited in both Claims 1 and 26.

The Office Action at page 5, however, observes that skew rolling is a well known rolling method, which is evidenced by the NPL-1 document ("*Fertigungs Technik*"). In particular, the Office Action notes that NPL-1 teaches skew rolling for tubes and/or rods, and from this proposition concludes that it would have been obvious to one of ordinary skill in the art to apply such a known skew rolling method to the process disclosed in Hathaway.

Applicants agree that skew rolling is a known process for metal forming. Insofar as pertinent, the NPL-1 reference confirms this point. However, Figure 5-24 of NPL-1 shows only that skew rolling with double-conical rollers can be used in the production of tubes, while Figure 5-25 shows that a slanted smoothing roller can be used to smoothen the tool marks of a turning process on the surface of a shaft (reeling). Finally, Figure 5-26 simply shows that slanted profiled rollers can be used to produce endless threads on a workpiece or rod. However, nothing contained in either the NPL-1 document or in Bilgen et al teaches or suggests that the use of a single skew rolling step, in combination with the heat treatment defined in independent Claims 1, 25 and 26 of the present application will initiate a dynamic recrystallization process within the steel microstructure of a solid steel rod, after a critical degree of transformation has been caused by the skew rolling and a desired structure distribution over the cross section of the rod. The result of the present process, and unique

combination of steps, is a heretofore unknown result, which has not previously been achieved.

In particular, the prior art does not recognize or suggest that a desired gradient in the degree of recrystallization of the steel rod over its cross section, resulting in a marginal area having a fine-grained martensite structure after the heat treatment, can be achieved by a single coordinated and concurrent heat treatment and skew rolling. (See, for example, Claim 25, which also recites these features in detail.)

Moreover, if a person of ordinary skill in the art were to apply the skew rolling technique taught by NPL-1 in the manner suggested in the Office Action, he or she would not arrive at the claimed invention, and would not obtain the particular described in the disclosure. That is, nothing contained in NPL-1 suggests performing skew rolling in such a way that:

a) a predetermined twisting of the material in a marginal area is achieved (a key factor in the development of the cited properties;

b) a desired transformation gradient is achieved over a cross section of the rod by virtue of the single step of skew rolling coordinated with heat treatment in the manner claimed in the present application; or

c) that a critical degree of transformation can be exceeded, so that dynamic recrystallization processes take place inside the steel microstructure.

Applicants also submit that the skew rolling/cross rolling methods disclosed in NPL-1 are not suitable to achieve the items a), b) and c) mentioned above. Bilgen et al, for example, simply refers to "dynamic and/or static recrystallization of the austenite". However, to perform the forming step according to the present invention, in which the dynamic recrystallization takes place in such a way that features a) and b) above are achieved (and thus a microstructure distribution is obtained over the cross section of the rod) is not disclosed or suggested. Rather, the overall purpose of the Bilgen et al patent, as described, for example, at Column 2, lines 31-36 is to obtain "an extremely fine-acicular martensitic microstructure", which is uniform over the entire cross section of the workpiece, and which is then tempered to obtain the desired strength-toughness combination. Neither the Hathaway patent nor NPL-1 would provide a person skilled in the art with any suggestion to achieve the features a) and b) above by applying a single special coordinated skew rolling and heat treatment step as recited in the claims of the present application.

While the NPL-1 reference certainly confirms that skew rolling is known, the combination of NPL-1 with Bilgen et al would not result in the method according to (for example) Claim 1, which recites steps of i) heating the rod to a

temperature that is above a recrystallization temperature, ii) equalizing its temperature, iii) causing it to be deformed by a single step of skew rolling such that a predetermined twisting of the material occurs in a marginal area of the rod, and a desired deformation gradient is achieved across a cross section of the rod, whereby after a critical degree of deformation is exceeded, dynamic recrystallization takes place with greatest intensity in the marginal areas, iv) reheating the rod to a temperature above Ac3 and then v) hardening and tempering it. It is this unique combination of a single skew rolling deforming step, together with the heating and reheating of the steel rod which achieves the desired advantageous characteristics in the end product, as described previously. Such a combination is not taught or suggested by NPL-1 and Bilgen et al, whether considered separately or collectively.

In summary, the present invention uses the combination of a single step of skew rolling, coordinated with heat treatment according to a particular pattern, to initiate a dynamic recrystallization process within the steel microstructure of a steel rod by imposing a critical degree of deformation in the material of the rod, especially in its marginal or peripheral areas. This feature of the invention is not taught or suggested by the cited references, and achieves a result which has not heretofore been known or achievable. Accordingly, reconsideration and withdrawal of these grounds of rejection are respectfully requested.

Applicants acknowledge that the Office Action includes a restriction requirement, as between Claims 1-18, 21, 24 and 25 (Group I) and Claims 26-44 (Group II), the latter having been added by the amendment submitted January 8, 2009. Accordingly, the Examiner has withdrawn Claims 26-44 from further consideration, on the ground that they are directed to a non-elected invention. However, for the reasons set forth hereinafter, Applicants respectfully traverse the restriction requirement, and request that Claims 26-44 be reinstated and considered herein.

As an initial proposition, Applicants note that new Claims 26-44 were originally included in co-pending Application Serial No. 10/551,538 as Claims 1-17. In the Office Action dated November 8, 2008, Claims 1-18, 21, 24 and 25 of the present application (all claims then pending) were provisionally rejected based on obviousness-type double patenting over Claims 1-17 of Application Serial No. 10/551,538. Implicit in this ground of rejection is that the claims which formerly appeared in Application Serial No. 10/551,538 are not patentably distinguishable from the claims of the present application. That being the case, having entered such a rejection, followed by a joinder of those same claims in the present application, Applicants respectfully submit that the entry of a restriction requirement, the basis for which is that the inventions are separate and distinct, is improper.

If the restriction requirement were maintained, and Applicants were then to submit a divisional application containing Claims 26-44, under 35 U.S.C. §121, entry of a double patenting rejection would thereafter be precluded, even though the divisional application was identical in all respects with Application Serial No. 10/551,538, in which such a double patenting was entered. Applicants respectfully submit that such a procedure would be wasteful and would impose an unnecessary and unwarranted expense on the Applicants.

Moreover, Applicants further submit that the restriction requirement in this application is also improper, on the ground that the claims of Group I and Group II embrace a single general inventive concept within the meaning of PCT Rule 13.1.

That is, as noted in the Manual of Patent Examining Procedure §1893.03(d),

> "A group of inventions is considered linked to form a single general inventive concept where there is a technical relationship among the inventions that involves at least one common or corresponding technical feature. The expression 'special technical features' is defined as meaning those technical features that define the

contribution which each claimed invention, considered as a whole, makes over the prior art."

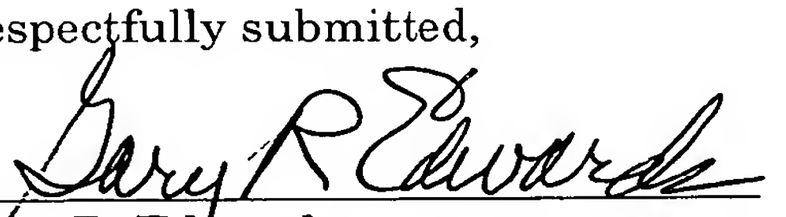
In this instance, Applicants respectfully submit that the "special technical feature" which is common to both groups of claims identified in the Office Action is the formation of a special steel structure/microstructure distribution by the claimed combination of heat treatment and skew rolling of the steel rods. More particularly, each of independent Claims 1 and 26 contains a step of "deforming said steel rod in a single deforming step coordinated with heat treatment of the steel rod". Moreover, each of Claims 1 and 26 further recites that the single step of deforming coordinated with heat treatment includes heating of the steel rod to a heating temperature that is above a recrystallization temperature, whereby the steel rod becomes austenitized, and skew rolling it. The result of this special technical feature is the creation of the special steel structure/microstructure-distribution, referred to previously. This feature of the invention is not taught or suggested by the prior art. Accordingly, it defines a "contribution which each claimed invention, considered as a whole, makes over the prior art".

For the reasons set forth above, Applicants respectfully traverse the restriction requirement, and request that Claims 26-44 be examined in this application. Moreover, Applicants respectfully submit that Claims 26-44 are allowable for the reasons noted previously.

In light of the foregoing remarks, this application should be in condition for allowance, and early passage of this case to issue is respectfully requested. If there are any questions regarding this response or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket # 103020.59950US).

Respectfully submitted,



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